REAL WORLD EXPERIENCE WITH MARKET-BASED TRANSPORTATION STRATEGIES: TECHNICAL MEMORANDUM

WORKING DRAFT

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Introduction

The New Jersey Department of Transportation is conducting a study to develop and evaluate innovative transportation control measures (TCMs) in the state of New Jersey. The purpose of this study is to identify and select a series of innovative strategies which may reduce the growth of vehicle-miles of travel, vehicle trips, congestion and mobile source emissions currently experienced on the roadway network throughout the state.

A very promising series of measures, termed market-based transportation strategies (MBTS), have been identified as offering longer-term potential to accomplish these objectives, as well as a shorter-term potential to supplement current Employer Trip Reduction Program (ETRP) options. Market based transportation strategies apply financial costs and incentives to reduce the level of use of vehicles on New Jersey roadways, and encourage the use of alternative travel modes, time periods, and/or cleaner burning vehicles. Importantly, these programs look at innovative ways to make vehicle owners more aware of the actual societal costs of using personal vehicles, and use pricing mechanisms and alternative travel options to help them evaluate the importance and need for travel via personal vehicle.

This technical memorandum provides an overview of much of the research, implementation, and application experience with MBTS strategies throughout the U.S. It is not a complete documentation of the experience and programs which have been developed. The document explores the motivations for consideration of MBTS measures, and identifies the social and political issues which have encouraged their current consideration in New Jersey, highlights the findings and projections of these strategies and summarizes the lessons learned from previous studies and programs. This memorandum offers a range of results to develop comparative approximations of program effectiveness, and encourages further discussion of the benefits and values of these strategies.

REAL WORLD EXPERIENCE WITH MARKET-BASED TRANSPORTATION STRATEGIES (MBTS)

A. MBTS BACKGROUND

1. Overview

Market-based transportation strategies (MBTS) are among the most current and progressive approaches available to control the growth of emissions, congestion, trips and VMT, but remain among the most experimental and least tested of transportation control strategies. Conceptually, MBTS measures apply a market-based approach to transportation choice behavior by pricing transportation services at levels which reflect the real economic as well as social costs of providing these services. From a user perspective, this allows individuals to make travel choice decisions based upon their willingness and ability to pay for the level of inconvenience and impacts their trips create. From a planning perspective, MBTS measures are primarily price coordination mechanisms allowing decision makers to balance the travel needs of individuals with the available resources of the transportation network.

A great deal of theoretical discussion has been generated regarding their applications, and related research and data developed to show their potential effects, yet few MBTS measures have ever been fully implemented. Pricing theory extends as far back as the 1950's (discussed as a means to define long term investment needs during the passage of the Federal Revenue Act) and the 1960's (through research addressing parking and congestion pricing). Implementation of some MBTS programs, however, began in several European and Asian nations during the 1970s and 1980s, where the need for strong measures to control burgeoning traffic growth and congestion levels became necessary. Application and/or testing of these measures were primarily constrained to urban areas, such as Hong Kong, Singapore, and Oslo/Trondheim. These early pricing measures were the focus of the Issue Paper prepared in Task 1.1 of this study. While some of these applications achieved the desired goals of the programs, others were abandoned or never implemented due to political and equity concerns by decision makers.

2. U.S. Background

Growing consideration of MBTS measures as solutions for difficult transportation problems has been heightened in the United States by a number of recent events. Most are the result of the original provisions of the Clean Air Act of 1970, and the strengthening and expansion of those provisions under the 1990 Clean Air Act Amendments (CAAA), which have mandated rigorous air quality improvement targets for many areas of the United States. These regulations have highlighted the difficulty of achieving the full range of emissions targets originally set forth in the 1970 legislation, and have created a need for new measures to further expand emissions reduction opportunities.

The 1970 CAA was designed to set and achieve national air quality goals for six pollutants using, in part, a number of regulatory tools, and was generally effective in all but one major

area: tropospheric ozone. Although the number of ozone exceedance days declined 68 percent between 1979 and 1992, national ozone concentrations barely declined, leaving 94 urban areas classified in "nonattainment" with regulations. This was partially due to the regulations being based upon a poor understanding of the complexity of the interactive properties of volatile organic compounds (VOCs), also known as hydrocarbons (HC), and oxides of nitrogen (NOx) in ozone formation, and overestimation of the role of VOC in the formation and reduction process.

A variety of mobile source problems contributed to the inability to achieve the air pollution reduction goals. Policies targeting technical (e.g., tailpipe emissions control) solutions for applications only to new vehicles in the fleet mix began to reach the limits of their effectiveness as more vehicles became equipped with air pollution control devices and achieved reduced emissions. Owners began to retain vehicles longer and increase the level of VMT driven by these vehicles, reducing the retirement rate of increasingly operated, emissions inefficient vehicles. While programs to repair faulty emissions systems on aging vehicles were initially encouraged, benefits from repair, in many instances, were ineffective. Evaporative emissions occurring during the "hot soak" cycle of vehicle use, were also discovered to play a far larger role in emissions than originally believed. Finally, overall VMT levels increased by 69 percent since 1970, due to many factors, including increasing suburbanization, the emergence of the baby boomers to driving age and expanding role of women in the workforce.

With the diminishing return of technical-based emissions control strategies, aging vehicle fleet and growth in VMT, the 1990 CAAA not only sought to tighten new vehicle emission controls, but to establish a wide-ranging program of enhanced inspection and maintenance (I&M), reformulated gasoline, alternate fuels and fleet development requirements, evaporative controls, transportation control measures (TCMs), and employer trip reduction (ETR) programs to address emissions. These mandates were backed up by requirements to document the rate of progress in emissions control efforts, and to tie capital program planning for transportation projects to the requirements of the CAAA. While many of these programs reflect a better understanding for the complexity of emissions reduction efforts, they still contain enough limitations to make cost effective implementation of strategies within the tight deadlines established by the CAAA problematic.[1]

These events have given reason to consider MBTS measures as the next level of mobile source emissions control strategies. MBTS programs encourage travelers to assess the value of their time and importance of their trip through their willingness to pay for (or accept financial incentives in lieu of) the level of inconvenience that their trip causes to others competing for space on available facilities, and for the amount of air pollution generated by the operation of their vehicle. In addition to congestion benefits identified by the earliest proponents, MBTS measures are now recognized to provide emissions, VMT, and trip reduction benefits. They also can be used to balance roadway usage patterns and levels, enhance revenues, improve the attractiveness of public transit alternatives and reduce roadway expansion capital requirements.

[1] Winston Harrington, Margaret A. Walls and Virginia McConnell, "Shifting Gears: New Directions for Cars and Clean Air," Resources for the Future, Discussion Paper 94-26, June, 1994, pp. 1 - 10.

The following section of this technical memorandum identifies MBTS measures considered for this evaluation, and discusses the types of benefits that each measure could provide.

B. IDENTIFICATION OF MBTS MEASURES

The Task 1.1 Issue Paper introduced an array of MBTS applications that have been explored throughout the U.S. and abroad, and developed discussion of the primary social and economic conditions and requirements for consideration and/or implementation of these approaches.

This effort provides further background on the history, pricing and technical applications of MBTS measures, and a summary of the performance and findings through the implementation and/or research performed to date. Specifically, the rest of this section will address the current state of practice in the use of MBTS measures by identifying and defining these measures, describing the evolution of their purpose and focus, their applications and testing, and the success or failure of these applications. In addition, conditions that promote or hinder MBTS measures, MBTS data requirements and availability, cost-effectiveness, the reasonableness of the measurement approach, institutional and political impacts, and revenue issues will be discussed where sufficient information is available to support analysis.

1. MBTS Identification

Following a review of many literature sources, a series of nine primary strategies were identified that have been or are currently being explored throughout the United States and the world. These nine measures largely reflect the state of practice in the development of market-based transportation strategies, and have been recommended for further consideration for a potential application in New Jersey:

- **Clunker Buy-Back**
- **Gross Emitter ID and Repair**
- **Emissions Fees**
- **Feebates**
- **Congestion Pricing**
- **Transit Pricing**
- **Pay at the Pump Insurance**
- **VMT Tax**
- **Parking Pricing**

2. Benefits

MBTS measures have been found to have a series of primary and secondary effects in their application to a specific market. Available research suggests that different measures serve different transportation and air quality objectives with varying success, and it is therefore important to understand the primary goals of each MBTS measure, how each measure functions and how each interacts with other measures.

Generally speaking, each of the nine (9) specific MBTS measures identified above has been found to have impacts in at least one of the following three (3) benefit areas: 1) Emissions Reduction, 2) Trip/VMT Reduction and 3) Congestion Reduction.

- **Emissions** pricing measures are strategies which increase vehicle operating costs based upon each vehicle's level of emissions. These measures largely target high polluting, usually poorly maintained vehicles in the fleet mix, and use market and/or enforcement measures to encourage owners to repair vehicles or retire older vehicles for new or newer vehicles to reduce fleet emissions. Four strategies have been identified that primarily address emissions: clunker buy back, gross emitter, emissions fees, and feebates.

- **Trip/VMT** reduction measures are strategies which target reduction of trips made by personal vehicles as their primary goal. Trip/VMT reduction measures tend to make the use of personal vehicles more expensive, or offer significant financial incentives for using alternative travel options. Four strategies have been identified that primarily address trips and VMT: transit pricing, pay at the pump insurance, VMT tax, and parking pricing strategies.

- **Congestion** pricing measures are strategies which mitigate the level of delay for vehicles in the traffic stream. Congestion measures largely target demand levels and patterns of use of existing transportation facilities, and use market and/or enforcement measures to encourage shifts in travel behavior that tend to reduce peaking characteristics associated with free or low cost travel options. One strategy has been identified as a measure that primarily address congestion: congestion pricing.

While all strategies have a primary, or main category in which they are designed to achieve benefits, some strategies have secondary, or supplemental categories in which they provide additional benefits. This technical memorandum organizes the research by primary benefit category and MBTS measure. Table 1 categorizes each measure in terms of its primary (designated by the letter P in bold type) and secondary areas of effect (designated by the letter S in standard type).

TABLE 1
MBTS PRIMARY AND SECONDARY REDUCTION BENEFITS

MBTS MEASURE	EMISSIONS	CONGESTION	TRIP/VMT
Clunker Buy Back	**P**		
Gross Emitter ID and Repair	**P**		
Emissions Fees	**P**		S
Feebates	**P**		
Congestion Pricing	S	**P**	S
Transit Pricing	S	S	**P**
Pay at the Pump Insurance	S	S	**P**
VMT Tax	S	S	**P**
Parking Cash Out	S	S	**P**

The following section of this technical memorandum will explore the range of applications under which MBTS measures have been applied or the theoretical constructs, study results, and general experiences and findings of these efforts.

C. STATE OF PRACTICE OF MBTS MEASURES

A review of current literature on the applications of MBTS measures shows that most MBTS experience has been limited to brief trial programs, or to measures that have similar basic pricing behaviors, mechanisms and/or effects. The majority of programs and study results tended to quantify only VMT and/or trip reduction levels, rather than emissions benefits. This is due to a variety of reasons, but primarily relates to the lack of focus on emissions issues prior to the 1990 CAAA, and for studies performed later, to the difficulty and lack of specific guidelines in defining the assumptions used to calculate emissions results.

Our research has emphasized evaluation of cost effectiveness as a range of results from several studies with similar approaches, rather than a comparison of specific cost effectiveness amounts. This approach has been adopted because underlying assumptions varied in a number of studies, and two approaches that had roughly the same cost per ton of emissions reduced may have had very different total emissions reductions.[2]

The results of this literature search process, summarized in Table 2 at the end of this section, provide an extensive listing of programs and studies for each MBTS category. For each entry, a summary is provided describing its application or study location, years of operation, status of the program, and brief comments regarding program findings and/or cost effectiveness.

Experience and evaluation summaries are based upon the information contained in the identified research materials and Table 2. This section is intended to provide a brief description, overview and summary of the current status of each MBTS measure, its effectiveness in those applications or research results, the institutional and political implications, public acceptance, and cost effectiveness associated with the actual/potential applications of each MBTS measure.

1. Clunker Buy Back

Description:
Clunker buy back programs are designed to purchase and scrap higher polluting vehicles to remove them from the vehicle fleet mix. The program objective is to remove the most polluting vehicles which cannot be economically repaired from the vehicle fleet mix to reduce emissions levels.

Experience:
Programs: Nine clunker buy back programs were identified through the research. Most appear to have been operated by petroleum interests, auto manufacturers, and/or utilities over limited periods of time to achieve specific objectives (e.g., obtain emissions reductions credits to offset other, usually stationary source, air pollution requirements for the company). Only one program (Unocal) is currently active, having recently begun a third phase during January, 1995.

[2] Winston Harrington, Margaret A. Walls and Virginia McConnell, "Shifting Gears: New Directions for Cars and Clean Air," Resources for the Future, Discussion Paper 94-26, June, 1994, p. 14.

Research: One research study was identified which used a model-based approach to estimate the benefits, costs and effects of an accelerated vehicle retirement program in the Pennsylvania portion of the Delaware Valley region.

Legislation: Legislation has been proposed in several states, including Connecticut, Texas and Virginia, which would allow clunker buy back programs to be developed as an emissions reduction strategy, but with few exceptions, has encountered opposition from auto repair and collector groups that fear a reduction in business or available vehicles/parts. These interests have sought inclusion of repair option clauses and other alternative measures to scrappage in the legislation. This strategy is currently allowed in some states as a replacement strategy for stationary source emissions requirements.

Technical Effectiveness:

The effectiveness of clunker buy back programs in reducing emissions is quite high, but its effects are short term. According to the literature, as much as 80 percent of mobile source emissions may be attributable to 15 percent of the worst or highest emitting vehicles.[3] The direct removal of a relatively small number of inefficient vehicles from the fleet mix could provide significant emissions reductions. Effects upon trip reduction/vehicle-miles of travel (VMT) and congestion are likely to be low.

Institutional and Political Implications:

A clunker buy back program would require administrative review of each proposed vehicle acquisition to prevent potential fraudulent vehicle scrappage schemes. This approach should ensure that eligible vehicles have been in active service, and disallow vehicles which may have been restored to operation for the purpose of selling them as clunkers.

Clunker buy back program legislation has already encountered opposition from specific interests that depend upon the repair and/or use of older vehicles and their component parts. These groups include the Coalition for Auto Repair Equality (C.A.R.E.), an organization which represents vintage car hobbyists and repair shops. C.A.R.E. prefers that emphasis be put on repairing high emitting vehicles instead of scrapping them, thereby ensuring the availability of vintage cars and used auto parts, and protecting the auto repair industry. While this opposition was instrumental in defeating a first round of legislation in New Jersey, the group has expressed support for modified legislation in other states which include some protections of their expressed concerns.

Public Acceptance:

Owners of clunkers have generally expressed strong interest in participating in clunker buy back programs. While this is largely related to the value of the financial incentive provided, the programs identified through the research, which offered between $500 and $1,000 per vehicle, have experienced moderate to overwhelming response from clunker owners. Concerns may be generated, however, by lower income owners who may find the financial incentive insufficient to finance the costs of upgrading to another more recent vehicle, and in providing the same funding level to other income groups which may potentially be better able to afford upgrading to newer vehicles.

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[3] "California Considers Alternatives to Trip Reduction Programs," Innovation Briefs, Vol. 6, No. 2, Urban Mobility Corporation, Washington, D.C., April, 1995, p.2.

Costs and Benefits:
Although the EPA has recently developed guidance regarding a methodology for estimating emissions credits for "clunker" programs,[4] few programs have used (or were able to use) this methodology. Others had to rely on the limited data to develop calculations of the cost effectiveness of a clunker buy back programs prior to the availability of the EPA guidance. Accordingly, cost effectiveness results for a clunker buy back program vary widely and are based on a variety of assumptions.

Based upon the research identified in Table 2, a wide range of cost-effectiveness results for emissions reduction were identified. HC cost effectiveness was found to range between $2,500 and $9,000[5] per ton, and NOx cost effectiveness between $12,000 and $69,000 per ton. A study performed by the Delaware Valley Regional Planning Commission (DVRPC) in May, 1994, using a variety of public and proprietary models, identified a far higher range of costs, with HC estimated at approximately $29,000 per ton and NOx estimated at approximately $52,000 per ton.[6]

2. Gross Emitter

Description:
A gross emitter program would detect vehicles within the traffic stream that fail to meet emissions standards, and encourage or require vehicle owners to bring vehicles up to required targets. The program objective is to reduce the number of environmentally inefficient vehicles in the active fleet mix through encouraging or requiring owners of non-complying vehicles to make repairs, and/or to encourage owners to purchase less polluting vehicles.

Experience:
Programs: Two gross emitter programs have been identified through the research process. One was conducted recently in Philadelphia, PA as an incentive-based program by a petroleum corporation and is no longer active. The second was a mobile enforcement-based program implemented in January, 1995 by Arizona state government, in which specially equipped mobile vehicles perform spot inspections of between 10,000 and 15,000 vehicles per day with no inconvenience to motorists to identify those not in compliance with emissions standards.

Studies: Nine studies were conducted during the late 1980s and early 1990s. These studies targeted several research areas, including accuracy tests of remote sensing technology, comparison tests to the standard IM240 vehicle inspection test, and potential applications and set-up requirements to ensure more accurate sensing.

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[4] Guidance for the Implementation of Accelerated Retirement of Vehicles Programs," U.S. Environmental Protection Agency, Office of Mobile Sources, February, 1993.

[5] Francis J. Cebula for Paul J. Durkin, "The Sunoco Emissions Repair Program," The Sun Company, 1994, pp. 1-3.

[6] "Transportation Control Measures An analysis of potential Transportation Control Measures for implementation in the Pennsylvania portion of the DVRPC region," Delaware Valley Regional Planning Commission, May, 1994, pp. 5, 100, 109.

Technical Effectiveness:

Review of the research suggests that remote sensing technology has progressively improved in accuracy since pioneering tests in the mid to late 1980s. Several different systems have been tested through the identified programs and studies, and continual advances are being made to enhance the accuracy of the technology. Sensors of CO have proven most reliable throughout the research, while the accuracy of HC sensors has varied substantially and NOx sensors are a relatively new and emerging technology. Because many variables can affect the accuracy of remote sensing technology, including placement of sensors, traffic density, roadway, grade, speeds, vehicle acceleration and deceleration characteristics, and proximity to cold start locations, readings can vary substantially. The ranges of accuracy identified by the different research studies have varied substantially, and most studies have recommended that more than one reading be performed before a vehicle is classified as a gross emitter. License plate video imaging systems have also been found to vary in accuracy, with illumination, weather conditions, and license plate number/background contrast contributing to the level of legibility obtained. At least one state (Idaho) has different styles of license plates that may allow repeated use of the same letter and number combinations, thus making identification more complex..

Remote sensing technology could be used in conjunction with a clunker buy back program to effectively "screen out" the highest polluting vehicles in the traffic stream for potential eligibility to the clunker buy back program. Since repairs on older vehicles are not always cost effective, a scrappage option could enhance emissions reduction effectiveness of a gross emitter program.

Institutional and Political Implications:

Regulatory acceptance of gross emitter programs would be required. This could include review of the acceptability of the use of video imaging technology to identify license plates of non-compliant vehicles. Although rapid technological advances have made remote sensing measurement more accurate and reliable, standards and procedures would have to be developed to ensure proper positioning of equipment, followed with more comprehensive (e.g., IM240) testing of vehicles failing remote sensing tests. While two identification and correction approaches, a voluntary (an advisory-based) and a mandatory (enforcement-based) strategy are possible, a mandatory program is more likely to encounter opposition.

Public Acceptance:

Although little of the available research has addressed potential acceptance of remote sensing technology, it is apparent that a high rate of accuracy would be required before proving acceptable for general use, especially as a regulatory measure. Since a significant level of error could cause extensive inconvenience to motorists in the form of re-inspections and unnecessary repairs, multiple testing and/or strict guidelines for sensor placement would have to be developed. It is also likely that public opposition will be lower for a screening and incentive-based repair program (an approach which identifies and notifies vehicle owners of potential emissions problems and provides vouchers to pay for vehicle repairs through a select group of service centers) than an enforcement-based approach. Unfortunately, the research also suggests that response to incentive-based remote sensing repair programs has generally been poor. A combination of incentive and enforcement strategies in a remote sensing application may prove more acceptable.

Costs and Benefits:
A number of variables, including system costs, vehicle repair costs, number of gross emitting vehicles and the required remote sensing frequency may affect the cost of remote sensing programs. Studies place the cost of CO reduced at between $200 and $700 per ton, and determined the average cost of vehicle repair to range between $50 and $200 per vehicle. HC and NOx reductions were identified to be significantly more costly, with a potential cost of reduction of between $1,300 and $6,000 per ton.

3. Emissions Fees

Description:
Emissions Fees (also referred to as "smog fees") are surcharges that would be added to a driver's annual vehicle registration fee based upon the type and age of vehicle owned. Because insurance fees for older vehicles currently tend to decrease over time, the cost of operation for older vehicles becomes less expensive. By charging older vehicles with higher emissions rates at a higher rate, the strategy could help to equalize the costs of vehicle operation over time and potentially encourage drivers to transition to newer vehicles.

Experience:
Programs: No applications of an emissions fees program have been implemented to date.

Studies: Four studies have been identified which estimate the potential effects of this type of program. California has reviewed the potential use of emissions fees based upon California Air Research Board data and model applications. The Regional Transportation Agency in Illinois has studied the potential effects of emissions fees should they be applied to northeastern part of the state, using information, based in part, on the California study findings. A detailed study of VMT and smog (emissions) fees was developed using Massachusetts vehicle fleet data. Finally, the Southern California Association of Governments (SCAG) considered a vehicle license fee proposal, that was ultimately defeated, which would have made older vehicles more costly to license.

Technical Effectiveness:
Without the practical experience of an application of an emissions fees program, it is difficult to determine the technical effectiveness of this type of program. Based upon the available research, application of an emissions fee can be performed as part of the annual vehicle registration process based upon a set level of fees based on the vehicle make, model and model year, or could more equitably be administered through actual emissions levels measured during vehicle inspection. An enhancement of existing emissions testing and reporting equipment would be needed to store, analyze and process the recorded emissions rates in the development of an emission fee rate structure.

In most of the research, emissions fees have generally been considered in conjunction with a VMT fees, which assess a charge for the actual usage levels of each vehicle. This is often considered as a mechanism to equalize the regressive effects of an emissions-only based program. Since emissions fees would most significantly impact lower income groups, which are the predominant owners of older vehicles more likely to incur higher emissions fees, the implementation of a concurrent VMT tax would tend to increase costs for those that drive more, traditionally in the middle and upper-income groups with more emissions efficient

vehicles with lower emissions fees. Emissions fees could be developed based upon the social costs of auto pollution within the region, they would be most effective if charged in fewer, larger payments for each vehicle.

Institutional and Political Implications:
Emissions fees may disproportionately impact lower to middle-income vehicle owners. Findings from the 1990 National Personal Transportation Survey (NPTS) reveal that lower-income drivers own a larger share of the older vehicle fleet than other income groups. Lower-income drivers are also more susceptible to pricing strategies based on ownership rather than use, since their average expenditure for the purchase of new and used vehicles represents almost 14 percent of their income, while only six to nine percent for middle and upper-income drivers. Because of these factors, lower-income drivers may be priced out of the auto-ownership market. Lifeline pricing, a means by which individuals most impacted by the program strategy can be provided reduced fee rates or subsidy support, or the implementation of a supportive complementary strategy such as clunker buy back, could be used to reduce negative effects for this group.

Public Acceptance:
Public acceptance of emissions fees would likely be low, as it most closely resembles an added tax to vehicle ownership. If implemented as part of a program of strategies (e.g., clunker buy back) offering incentives and/or alternatives, public acceptance may be improved to some degree. Equity concerns may also be raised by drivers that travel out of state on a frequent basis, since they are paying for emissions not occurring within their home state. It may also be desirable to investigate whether out-of-state vehicles that travel primarily within the home state could be charged under an emissions fees program.

Costs and Benefits:
Emissions fees can be designed as either revenue neutral or revenue enhancing programs. A revenue enhancing program could use revenues to finance lifeline pricing options for lower income vehicle owners. Research suggests that an emissions reduction of between three (3) and sixteen (16) percent is possible through the implementation of an emissions fee. Although an emissions fee may reduce emissions through encouraging shifts to cleaner vehicles, it is unlikely to significantly reduce the amount of travel (VMT or trips) which occurs.

4. Feebates

Description:
Feebates would add a rebate or a fee to the purchase cost of a new vehicle based upon the emissions efficiency of the vehicle. Rebates and fees would be assessed to individuals in proportion to the efficiency level of the new vehicle versus an established emissions efficiency threshold. The objective is to develop a revenue-neutral approach (at least initially) to encourage drivers to choose more emissions efficient vehicles when considering the purchase of new vehicles.

Experience:
Programs: One feebate program was identified through the research. This currently operational feebate program can be found in the Province of Ontario, Canada, where fuel conservation taxes and tax credits are built-in to the cost of new vehicle purchases, and may

charge as much as $4,400 or return as much as $100 per vehicle based on emissions performance. These values, not typical of a revenue neutral feebate program, are heavily skewed since the program is designed for revenue enhancement.

Legislation: Legislation has been proposed by several states, although none has been implemented to date. One legislative action, part of the proposed DRIVE+ program passed by the California Assembly during 1990, was later vetoed by the governor due to political concerns.

Technical Effectiveness:
A feebate program is technically feasible, and could be administered through similar mechanisms to state excise tax and registration fees imposed on new vehicle purchases. Experience with feebates has been limited in the sole Ontario, Canada application, where its effectiveness is still unclear. This is because the feebate has been "built in" to the final vehicle price and its visibility to customers reduced, and it is uncertain whether customer purchase decisions have been affected by the program.

Key issues related to a feebate program are selection of the type of pollutant upon which a feebate would be based, the feebate structure for different types of vehicles (e.g., cars, trucks), and effects upon vehicle manufacturing and quality. Selection of an appropriate criteria pollutant is important, since certain types of pollutants may be more readily addressed by improved vehicle design and technology standards than others. Because feebates encourage a progressive shift of purchase decisions toward more emissions efficient vehicles, the feebate threshold point should continue to move toward cleaner burning vehicles until it is no longer technologically possible to improve emissions efficiency levels.

Research also suggests that the emissions reduction effectiveness of a feebate program may range from low (if implemented independently) to medium (if implemented with other complementary MBTS strategies). If implemented independently, effectiveness may be low because only new car purchases would be affected, and the strategy may encourage the retention of older vehicles for longer periods of time. A feebate could also have a low level of effectiveness when the value of the feebate, relative to the purchase price of the vehicle, does not prove sufficient to affect purchasing decisions. A potential problem with feebates is that they could impact the marketability of new vehicles, and auto manufacturers may shift their production plans because of feebate rate differentials. These changes could include lower quality vehicles standards and/or relocation of production to areas with lower labor costs. Effectiveness may be enhanced when combined with other programs (e.g., clunker buy back), which could provide added incentive and emissions reduction opportunities for more price-sensitive income groups

Institutional and Political Implications:
Feebate programs have generally been proposed based on vehicle fuel consumption levels or vehicle wheelbase size, but pure applications of these approaches may present difficulties. A consumption-based feebate could tend to favor smaller, more fuel-efficient cars (potentially favoring imports over domestic manufacturers) while trucks (a traditionally strong market for domestic manufacturers) could be penalized. A size-based feebate, which would base emissions strictly on vehicle size by category of vehicle (e.g., sports cars, sedans) could encourage a shift to production of larger, less-efficient vehicles without stringent controls to prevent vehicles from changing vehicle category. A combination program using size and

consumption, as well as other possible factors (e.g., domestic content, safety, etc.) could be developed to offset many of these negative factors.

Public Acceptance:
Public acceptance of a feebate program would be mixed. Auto manufacturers and unions are likely to strongly oppose a feebate program (as they did with the DRIVE+ legislation in California), since the program could have serious repercussions to import/export and car/truck market and production issues. Public reaction would generally be mixed, largely depending upon whether a payment or rebate would be associated with the purchase of the vehicle of choice for each individual.

Costs and Benefits:
Although most strategies call for a revenue neutral approach, a revenue enhancing feebate strategy could be used to discount alternative fueled vehicles, or subsidize program inequities (if they arise). While feebates do not reduce vehicle travel, they are likely to make the vehicle fleet less polluting. The Ontario, Canada application is primarily designed to generate revenue, since the feebate threshold point is heavily skewed towards fees. Revenues from this program are used for program administration and other general needs of the provincial government.

Studies suggest that long-term feebate emissions reduction benefits appear to be low. This is because feebates would only affect new vehicles brought into the fleet mix, and because these vehicles would likely only experience marginal changes in emissions efficiency from implementation of a feebate program. One research study estimated that application of a feebate program in the Philadelphia, PA region could reduce 71 tons of VOC and 43 tons of NOx emissions. While the reduction is significant, it is based on a modeled projection of only a 2.2% per year improvement in fuel economy of new vehicles and emissions reduction.

5. Congestion Pricing

Description:
Congestion pricing would employ time-of-day or vehicle occupancy pricing strategies on toll road facilities to influence demand levels on facilities. Strategies would seek to increase direct travel costs to individuals during peak usage periods on these facilities, encourage drivers to travel in less congested periods, encourage increased vehicle occupancy or use alternate modes to reduce emissions levels.

Measures:
- Point Pricing
- Congestion Pricing
- HOV Buy In
- Variable Toll Reductions

Experience:
Programs: Eight congestion pricing programs have been or are in the process of being implemented throughout the world. Of these eight, six are currently operational, one is under development, and one was tested but not implemented. Most have been developed by central or municipal governments or highway authorities as measures to control access to congested CBD locations. Only one of these, a private toll road project in Southern California, that is currently under construction, is located in the U.S.

Studies: Six proposed applications/studies were identified, of which three are U.S.-based. Programs include a point pricing test program for a major river/bay crossing (Oakland, CA Bay Bridge Tolls Pricing), an HOV lane "buy-in" option (I-15 near San Diego, CA), and proposed electronic toll collection (ETC) and time-of-day pricing on a tollway facility (S.R. 91 Toll Road in Orange County, CA).

Legislation: One legislative action was taken by the Swedish government to allow for implementation of congestion pricing strategies near Stockholm, but further action has been deferred.

Technical Effectiveness:

Congestion pricing has been proven to be effective in both manual (e.g., toll collection, windshield permits) and technology-based (e.g., ETC, AVI) applications, and may be implemented as either a flat-rate or time-of-day approach. Technical factors key to the success of congestion pricing include development of a rate structure sufficient to encourage changes in travel behavior, and application to well-defined and specific areas or zones.

Congestion pricing may be selectively imposed on existing tolled facilities through a stratification and stabilization of certain rates by time of day and/or season when toll increases are implemented. This approach could allow tolls to be increased during selected congestion periods while keeping tolls at the original or other reduced level for other time periods. Since most studies have reported high accuracy rates and minimal transaction costs with AVI technology (as low as $.20 per vehicle), automated pricing could make a large scale program quite feasible.

Institutional and Political Implications:

Concerns over the acceptability of specific congestion pricing applications, (e.g., an HOV buy-in program) with regard to federal funding requirements, bond covenants (on existing toll roads) and state regulations, must be considered. Implementation of a congestion pricing program may also extend across current agency jurisdictions, and may require development of separate entities or changes to existing agency mandates to implement. Other issues which require consideration include enforcement and enhancements to alternative transportation modes.

Political support is critical to congestion pricing applications due to potential concerns about public acceptance. In spite of having a program ready for implementation, a recent federally funded toll pricing experiment for the Oakland Bay Bridge in San Francisco, CA could not find one legislative sponsor to advance the project. Notably, many of the programs which have been successfully implemented were developed in countries with strong central government planning programs, or which have gained popular support through effective education and social awareness efforts.

Public Acceptance:

A variety of interests affected by congestion pricing are likely to oppose implementation of congestion pricing, especially if the approach involves increasing fees beyond the current costs of roadway usage. These groups include trucking and automobile associations and interests, employers, businesses, developers, and motorists. Other concerns involving an increased pricing approach include maintaining economic vitality and competitiveness of the region, mitigating potential impacts to lower income motorists, identifying the uses of

revenues collected, privacy concerns associated with technology applications, enforcement feasibility and acceptance, and the perception of double payment for roads through both taxes and tolls. Support could be generated however, through a revenue-neutral approach which offers reduced rates during off-peak periods.

Costs and Benefits:
Congestion pricing strategies may be designed as either a revenue neutral or revenue enhancing program, based upon the rates charged and application of revenues. Most literature does not quantify the emissions effects of congestion pricing, although some literature suggests that emissions reductions are likely due to reduced travel to targeted areas and/or improved average travel speeds. Although strongly dependent upon the rates charged and time of day when implemented, benefits identified through the research process suggest a reduction in vehicles per hour of from between five and 23 percent. Higher reductions have been estimated in some studies, and although actually achieved in one specific application (a 50 percent reduction was reported in a Milan, Italy), further information about this program is not currently available.

6. Transit Pricing

Definition:
Establish a series of pricing strategies for transit fares to reduce travel demand on roadway facilities and to significantly increase transit usage. Strategies would seek to lower transit fares sufficiently to attract individuals to transit services during peak congestion periods.

Experience:
Programs: Four programs were identified which provided or would provide direct incentives to transit use. Three were off-peak free-fare programs implemented as part of studies sponsored by UMTA (predecessor to the FTA) and operated for durations of between one and three months. The fourth was a proposed program by a transit operating agency which would have increased the number of free transfers between routes, removed a second fare zone, and offered deep discounts for multiple-fare ticket purchases. This action has been deferred pending resolution of budget and political concerns.

Technical Effectiveness:
Although many transit agencies currently employ differential pricing to promote off-peak usage of their systems, few have developed or tested the application of reduced or free fare strategies to encourage increased ridership during peak periods of roadway congestion. This may be due to the fact that 1) roadway and transit peak usage periods often occur during the same time periods, (particularly AM and PM peak periods) when transit ridership is a strongly inelastic market and when vehicle fleets are taxed to the limit, and 2) any adjustment could curtail system revenue while increasing vehicle (capital) requirements. The free-fare pricing experiments for off-peak services found that although usage levels increased significantly (as much as 50% during free fare periods), these gains generally evaporated when the programs ended, and may have included trips generated that might not otherwise have been made. It is unclear what the effects on emissions and congestion were, since the studies did not assess these variables.

Transit pricing strategies may prove more effective in conjunction with other MBTS programs by complementing measures such as episodic controls, congestion pricing, VMT Tax, parking pricing, and others by creating an attractive and more affordable alternative to the use of personal vehicles. They are not likely to perform well in markets that: 1) are not currently well served by transit, 2) have excessive transit travel times versus auto, even under congested conditions, 3) have transfer requirements, 4) are more costly in relation to personal vehicles, 5) have inconvenient fare payment systems, 6) have inadequate service levels and/or durations, 7) have access constraints to the system, 8) offer limited transit information, 9) may be perceived to have security problems and, 10) have reliability/frequency of service limitations.

Institutional and Political Implications:
Transit pricing strategies may have significant revenue impacts upon transit operators, and would likely require resolution of funding issues and possibly formal approvals as part of tariff regulations. Depending upon transit pricing program applications, equity concerns may be generated based upon where and to what extent incentives are offered. Although transit pricing strategies are likely to prove politically popular, the level of support would be correspondingly affected by these issues.

Public Acceptance:
Transit pricing strategies are likely to experience strong public support, with little or no direct public or interest group opposition, since these measures benefit a wide constituency and achieve popular goals. Equity concerns over where and what types of transit pricing incentives are provided are more likely to be issues of public concern.

Costs and Benefits:
Although ridership gains of up to 50% were reported in one free-fare experiment (not involving congested travel times), revenue losses of approximately 40% were also reported. Most studies identified a return to pre-experiment ridership levels upon termination of the program, however, a few have reported sustained ridership gains of up to eight percent. This may not be entirely attributable to the transit pricing program, as other changes to services and marketing, as well as exogenous economic variables, may have also influenced the results of the study.

7. Pay at the Pump Insurance

Description:
A surcharge would be added to the price of each gallon of fuel to directly provide liability insurance coverage for drivers. This would increase the price of travel only in direct proportion to the amount of fuel used for travel, minimize the current problem of under and uninsured motorists, and potentially result in long-term reductions in motorist insurance rates. Drivers would still be required to retain comprehensive coverage with the insurance company of their choice, with rates based on owner and vehicle characteristics (e.g., driver/vehicle age, type of vehicle owned, driving record, etc.). The program objective is to induce changes in travel habits by charging drivers for insurance costs based upon the actual usage of their vehicles, to make the cost of auto use more directly known to drivers, and to encourage long-term shifts to non-auto modes.

Experience:
No known pay at the pump Insurance program applications or research studies have been identified. Although pay at the pump insurance most strongly resembles a gasoline tax strategy, and some discussion can incorporate research and experience in this area to evaluate the concept, there is little basis upon which to develop supporting discussion.

Technical Effectiveness:
There is no practical experience of an application of a pay at the pump insurance strategy, although gas and motor fuels tax programs, which result in similar price increases, have been successfully implemented. To implement the program, automobile insurance would be divided into two parts: the fixed-cost element reflecting individual driving risk premiums paid directly to insurance agencies, and the variable cost portion paid at the pump for liability coverage. One proposed pay at the pump insurance strategy would divide registered vehicles into statistically homogenous blocks of between 2,500 and 5,000 vehicles, and invite auto insurers to bid for these blocks by auction. The state could then collect the premiums and disburse the revenues through authorities or mechanisms designated in the founding legislation.

Institutional and Political Implications:
Pay at the pump insurance would likely require legislative action to implement. Those insured would still have the right to initiate legal action against insurers, and would also have the ability to seek additional coverage above the basic liability levels. At an institutional level, opposition to a pay at the pump insurance program could be generated by those closest to the current insurance industry (e.g., lawyers, insurance companies and agents) that may perceive to be negatively impacted by this type of program.

Pay at the pump insurance is non-regressive, since lower income users tend to drive less and fuel costs are proportional to the level of driving performed. Potential concerns include increased out of area fuel purchases near border areas of the program region, increased travel activity to purchase fuel in the non-affected areas, potential under-reporting of sales and smuggling activities.

Public Acceptance:
Although the literature suggests that the public would derive clear benefits from the program, the program revenues must be clearly dedicated to an insurance use. This is necessary to ameliorate concerns that a pay at the pump insurance strategy could be masked as an added tax to roadway use. Also, such a program may be perceived by some as supporting increased governmental management of what is seen as a private activity.

Costs and Benefits:
Pay at the pump insurance may be designed as a revenue-neutral or revenue enhancing strategy, although it would gain wider support as a revenue-neutral program. One source has estimated that a $0.40 per gallon insurance fee would be necessary to cover the costs of a revenue neutral program.

Although information regarding pay at the pump insurance effectiveness is limited, a gasoline or motor fuels tax has similar characteristics which have been more thoroughly discussed in the literature and applied in various forms. Literature suggests that the public would derive clear benefits from the program through lowered insurance costs through the minimization of

uninsured motorists. Also, urban area users, who tend to drive less, may experience reduced costs. Results from gasoline and motor fuels tax studies indicate that motorists are highly inelastic (insensitive) with respect to fuel price, and that a tax hike of between one and two dollars per gallon (or more) would be necessary to have any significant effect upon travel behavior, especially work travel. A range of rates between $0.12 and $2.25 per gallon has been cited in recent literature. One study suggests that a $0.50 increase in gasoline taxes would result in an 11 percent reduction in vehicle miles traveled providing an emissions reduction benefit of 37 tons per day (a $1.00 increase would result in a 22 percent reduction in VMT) in the Chicago region. Another fuels/tax study estimated that an emissions reduction of between 10 and 30 percent is possible with a pay at the pump insurance program.

8. VMT Tax

Description:

A VMT (vehicle miles traveled) tax is a directly-applied surcharge based upon the level of vehicle and/or roadway usage. The program objective is to reduce emissions and travel by increasing the cost of vehicle usage on a per mile basis. Since VMT (along with vehicle fuel combustion efficiency) has a direct effect upon the level of emissions, a VMT tax attempts to make the cost of auto use more visible to drivers.

Experience:

Studies: No VMT tax programs have been implemented to date. Both Illinois and California have studied the potential implementation of a VMT tax, and have developed limited estimations of the impacts of such a program. The Illinois study targeted the northeastern part of the state near Chicago; the California study targeted the southern part of the state. DRIVE+ legislation passed by the California legislature during 1990, included VMT tax provisions, but was vetoed by the governor due to political concerns.

Technical Effectiveness:

A VMT tax could be effectively applied though an approach as simple as recording each vehicle's current odometer reading, to an approach as complex as Automatic Vehicle Identification (AVI) systems or through on-board measurement devices. In its simplest form, a VMT tax program could charge a rate per VMT levied in lieu of, or in addition to, each vehicle's registration fee. Readings of VMT could be taken at the biennial motor vehicle registration or inspection periods by the Division of Motor Vehicles (DMV) by comparing current versus the previous odometer reading (or based on zero mileage for new cars). This process would be enhanced by the use of AVI technology which could afford a more frequent review and assessment of VMT fees. The DMV would then bill the vehicle owner (on an annual or a quarterly frequent basis) based on the VMT reading for the year. A process by which the DMV could record and track each vehicle's annual odometer reading on an annual basis would have to be developed to ensure against fraudulent out-of-state registrations and odometer tampering attempts to avoid charge.

It is often proposed that a VMT tax be implemented in conjunction with an emissions fee, since the combined effect of these measures is to reduce both the level of travel and to "clean up" the emissions quality of the balance of vehicles used for travel.

Institutional and Political Implications:
A VMT tax may encounter significant opposition from political sources because of negative effects upon equity between different income and user groups, concerns regarding charges for out-of-state VMT, and the imposition of additional costs to motor vehicle users.

Although the highest charges in a VMT tax would be incurred by upper and middle income groups, lower income groups may still require "lifeline pricing" because their fees form a larger proportional share of their income. Businesses which require extensive vehicle use (e.g., delivery services, utilities, trucking firms) may also be strongly impacted by a VMT tax, and consideration of measures to reduce the impacts to these groups may also be necessary. Charges for VMT occurring out of state may also cause concerns among legislators. These charges would occur for travel in areas not subject to taxation, and could raise legal concerns. Perhaps most seriously, a VMT tax would directly raise the costs of driving to the public, and could prove unpopular with constituencies. Petroleum interests and auto manufacturers may oppose this measure, since it reduces demand for their products.

Public Acceptance:
Public acceptance of a VMT tax is likely to be low, considering the direct increase in costs that would be incurred by motor vehicle users. Success in implementation would require strong public outreach efforts to ensure that a VMT tax is not simply perceived as another registration tax, but a user-based fee which encourages more efficient use of vehicle, emissions and roadway resources. The administration and billing cycle procedures are also crucial to the success of this type of measure, and require careful consideration about the frequency and ease of payment for this program.

Costs and Benefits:
VMT tax may be designed as a revenue-neutral or revenue-enhancing strategy. A revenue neutral approach would be priced at a break-even level, and return most or all revenues to administration, lifeline pricing, and remediation payments for potential program inequities through a rebate or differential rate setting process. A revenue enhancing strategy would cover costs, as well as increase revenues, through charging a higher per-mile fee.

A fee of anywhere between $0.01 and $0.11 per mile has been suggested in most literature sources. Some studies have suggested that fees of between $.02 and $.05 per mile could provide between a three and ten percent reduction in emissions.[7] Since costs to users have been estimated to range anywhere between $500 and $1500 per year per vehicle, strong consideration of frequent payments (possible quarterly or monthly installments) may be necessary to prevent certain users from being priced out of the auto ownership market, and could offer an enhanced method of ensuring that these costs are perceived as user-generated fees, rather than as a registration tax add-on.

[7] Transportation Pricing for California: An Assessment of Air Quality, Congestion, Energy, and Equity Impacts, Volume 1: Summary Report, prepared by G. Harvey, E Deakin et. al., for the California Air Resources Board, October 1994.

9. Parking Pricing

Description:
A parking pricing program seeks to reduce the use of personal vehicles through the imposition of fees or incentives related to parking, with the majority of programs applied to employer-based parking. These financial incentives alter the costs of single occupant vehicle (SOV) travel to work, and are designed to impose direct financial costs which incorporate the real costs associated with parking. The strategy would induce some of these motorists to use other alternatives, such as, ridesharing and transit, thereby reducing the number of solo drivers and creating emissions reductions.

Measures:
- Parking Pricing
- Parking Cash Out

Experience:
Programs: Eight public sector programs were identified from the research as representative examples of parking pricing programs. These were primarily implemented during the 1970s and 1980s, and increased the cost of municipally-controlled parking (some by time-of-day) to rates approximating those at privately owned lots. Two representative examples of private employer parking pricing strategies were identified as representative examples from a multitude of strategies developed as part of employer trip reduction programs underway in several states. These programs were designed to allow employers to charge employees for parking as a method of reducing trips to the workplace. Finally, results from four California parking cash out strategies have been identified. Federal tax code adjustments are required before cash out incentives can be offered by employers on a tax-free basis.

Studies: One study used a model based approach to estimate the effects of a parking charge placed on all employer-based work trips to the Philadelphia, PA central business district.

Legislation: California passed legislation in the form of Assembly Bill 2109 in 1992 supporting parking cash out programs, but conflicts with federal tax codes have prevented employers from developing widespread implementation of a tax-free parking cash out program to date.

Technical Effectiveness:
Parking pricing strategies fundamentally depend upon the ability to monitor each vehicle parking within a specific area or location. Although the majority of parking pricing strategies have been implemented using manual enforcement methods (e.g., parking attendants, restricted access lots, parking stickers), they could alternatively be implemented using modern AVI-based electronic technology. Reduced/free rates for rideshare vehicles are sometimes offered,

The emissions effectiveness of parking pricing strategies can potentially be high, but results are dependent upon the specific application and approach developed. Municipal-based parking pricing programs (largely implemented in controlled or enforced urban parking areas) as well as employer-based ETR parking pricing strategies have resulted in a variety of responses, including reduced SOV levels, diversions to other parking locations, increases in transit use, and in some cases, the counter-intuitive result of increased ridesharing with reduced transit use. Specific factors affecting travel behavior include rates charged or

incentives offered, parking availability in other nearby locations, and the availability of travel alternatives.

Institutional and Political Implications:
Political support for parking pricing programs may vary by type and application. Although both pure parking pricing and parking cash out approaches could generate modest revenues, pure parking pricing strategies which seek to increase costs to drivers may prove politically unpopular. Parking cash out programs use financial incentives to allow drivers a choice, and are likely to prove the more acceptable of the two options.

Parking pricing programs may encounter opposition from developers and construction firms that may realize a financial loss from reduced parking needs. These firms may also perceive the program to threaten existing development goals and regulations which they may favor, or may affect the marketability of their sites to investors and tenants. Concerns may also be expressed by areas which could be impacted by a spillover of parking to non-priced streets and lots. A carefully coordinated program of parking restrictions and access controls could ameliorate many of these concerns. Depending on whether an employee receives a financial incentive, there may be state and or federal tax consequences.

Public Acceptance:
Pure parking pricing strategies which increase costs to drivers could generate significant public opposition. A parking cash out approach offers drivers financial incentive which may be spent at the discretion of the employee, allowing them to switch from their personal vehicle to alternate transportation options or to use for other purposes, and would likely generate public support.

Costs and Benefits:
Parking pricing programs may be designed as either revenue-neutral or revenue-enhancing strategies. Funds from a revenue-enhancing approach could be applied to support transit and other alternative transportation subsidy programs, to municipalities as compensation for potential overflow parking impacts or to fund municipal roadway/transportation improvements.

Research suggests that parking pricing programs have demonstrated that SOV trips can be reduced by up to 36 percent, with the majority of programs offering reductions of between 22 and 30 percent. While emissions impacts of parking pricing strategies have generally not been calculated, one study used a model based approach to estimate a potential annual emissions reduction of 475 tons of HC and 627 tons of NOx based on a $3.00 parking fee in the Philadelphia, PA CBD. In terms of income, substantial revenues can be gained with modest investment in a parking pricing program. Programs implemented in the early 1980's for Eugene, OR and Santa Cruz, CA revealed that although administration and enforcement efforts for these programs cost between $30,000 and $50,000 per year, operating costs were recovered through parking revenues and citations. Gross revenues from San Francisco parking tax amounted to $5.5 million per year, and increased revenues were observed in Chicago despite the fact that the city only controlled 14 percent of parking spaces in the CBD. Estimated savings in construction costs for structural lots were placed at $4,200 per space, and $200 in annual operation and maintenance costs per year due to long-term reduced parking needs.

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TABLE 2
MARKET-BASED TRANSPORTATION STRATEGIES
STATE-OF-PRACTICE SUMMARY

SPECIFIC MARKET-BASED STRATEGY	PROJECT SPONSOR	APPLICATION LOCATION	PROGRAM YEAR(S)	STATUS	COMMENTS
CLUNKER BUY BACK	Union Oil Company (Unocal) SCRAP Program.	Los Angeles, CA	1990, 1993, 1995*	Completed; *Operational	9,200 pre-1972 vehicles purchased and scrapped for $700 each in 1990 and 1993 phases. Cost-effectiveness over 3 year period:2,606/ton HC & $21,015/ton NOx. New phase - January, 1995.
	Project Clean Air	Kern County, CA	1992?	Completed	Volunteer citizens effort worked with banks and auto dealers to encourage owners to dispose of pre 1975 vehicles and purchase 1984 or newer vehicles.
	General Motors, Mobil Oil, Env. Def. Fund, Illinois EPA	Chicago, IL	1992	Completed	207 pre-1980 vehicles purchased & scrapped for $750 each. Cost-effectiveness: $3,461/ton HC & $21,951/ton NOx.
	U.S. Generating Company / Resources for the Future	Delaware	1992	Completed	125 pre-1980 vehicles purchased and scrapped for $500 each in 1992. Cost-effectiveness over 1.7 year period of $5,000/ton HC and $68,180/ton NOx. Study found that price offered effects turnout and remaining lifespan of clunkers.
	Total Petroleum	Denver, CO	1993	Completed	488 gross emitters identified, 218 repaired, 270 scrapped (parts salvaged) at $1,000 per vehicle. Cost-effectiveness: $12,195/ton HC.
	Old Vehicle Clearinghouse	So. California	1994 - 1995	Ongoing	800 pre-1972 vehicles purchased & scrapped for $700 each. Cost-effectiveness over 3 year period: $4,242/ton HC & $15,555/ton NOx.
	Chevron C.A.R. Program	SCAQMD, CA	1993	Completed	$700 offered for each pre-1972 vehicle.
	Sun Oil Company	Philadelphia, PA CMSA	1993	Completed	166 pre-1980 vehicles purchased and scrapped for $700 each. Cost-effectiveness over 3 year period: $8,607/ ton HC & $13,356/ton NOx.
	NJ State Legislature: McNamara Bill	New Jersey	1994	Defeated	Legislation introduced to allow clunker buy back programs. Objections from auto repair and collector action groups defeated current legislation. May resurface with modifications this year
	State Governments	Various States	1994-1995	Pending	Maryland, Connecticut, California, Texas, Colorado, and several other states considering clunker buy back strategies. Opposition from repair and collector groups occurring.
	Delaware Valley Regional Planning Commission (DVRPC)	Philadelphia, PA CMSA	1994	Completed	Study used models to estimate effect of replacing 50% of pre-1980 vehicle fleet at $700 buy-back and $50 administration cost per vehicle. Cost-effectiveness over 3 year period: $28,720/ton HC & $57,170/ton NOx.
	State Government	Virginia	1994	Operational	Motor Vehicle Scrappage Program passed. Will provide $700 for each pre-1981 vehicle voluntarily scrapped.
EMISSIONS FEES	Southern California Association of Governments	California	1975	Defeated	Proposed vehicle licensing fee making older cars more costly to license; encouraging vehicle scrappage. Defeated due to equity concerns.
	Regional Transit Association	Illinois	1992	Analyzed	A one dollar gas tax was projected to lead to a VMT reduction of over 22%.
	Conservation Law Foundation	Massachusetts	1993	Analyzed	Discusses elasticity measures and effects for a combined VMT/emissions fee program based on Massachusetts vehicle fleet data.
	California Air Resources Board	California	1994	Analyzed	Estimated effects of a combined VMT/emissions fee on the Sacramento, San Francisco, and Los Angeles areas. A six to ten percent emissions reduction was estimated.
FEEBATES	Ontario Ministry of Finance	Ontario, Canada	1989 - 1995	Operational	Program administered through built-in fuel conservation taxes and tax credits applied to new vehicle purchase price. Maximum tax levied on new vehicles: $4,400; maximum credit: $100. Different rates for light trucks, sport vehicles.
	State Government	California	1990	Defeated	DRIVE+ program was passed by legislature, but vetoed by Governor due to opposition from taxpayer groups and auto industry.
	Delaware Valley Regional Planning Commission (DVRPC)	Philadelphia, PA CMSA	1994	Analyzed	Study estimated minimal emissions benefit using EPA test case of fuel economy as measure. Maximum fee set at $1,364 and maximum rebate of $395.

D. SUMMARY

1. Assessment:

This document provides an overview of the theory, practical applications and effectiveness of market based transportation strategies through the review of experiments, case studies, and research documents. While the review has not conclusively quantified benefits for strategies because of the variety of studies based on different design assumptions, there is strong supporting evidence that these strategies offer an effective, efficient and potentially low cost approach to reducing emissions, congestion and trips/VMT.

Market-based transportation strategies have been implemented successfully, and where experimental programs were tested for trial periods, their results have revealed important lessons that can be used to change program design, avoid previously experienced difficulties, and build in safeguards for future program development. Review of the research has provided important direction in assessing the strengths and weaknesses of each measure, and has identified the types of travel situations and spatial applications which may prove most effective. The technical memorandum on analysis will more specifically tailor the findings of this research to New Jersey data, and will provide a more comprehensive and thorough assessment of the potential of these MBTS measures in New Jersey.

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PARKING PRICING	Municipal Government	Madison, WI	1980	Operational	Peak period surcharge at municipal garages combined with new shuttle service. 22% shifted parking location, 5-8% shifted to transit, and 6% parked after peak.
	Municipal Government	Seattle, WA	NA	Operational	Discounted carpool parking at two municipal garages (80% discount at one, free parking at the other). Largest effect was to switch bus riders from transit to carpool (45% of participants); 29% previously carpooled; 25% previously SOV driver.
	Municipal Government	San Francisco, CA	NA	Operational	Raised parking rates at garages through a 25% tax. Overall number of parked cars declined 2%, and duration of parking declined. Parking demand decreased at seven garages but increased at six. Parking elasticities ranged between +.40 to -2.65.
	Municipal Government	Chicago, IL	NA	NA	Raised municipal rates by 30-100% to commercial levels. Parked cars declined by 35%, parking duration decreased (all day parkers arriving before 9:30 AM declined 72%). Although most switched to transit or carpools, no mode shift data available.
	Municipal Government	Eugene, OR	1980	Discontinued	Raised municipal rates at two garages and several surface lots over 100% during one year. Permit users declined 36%, with half using carpool or transit, and the other half changing parking locations.
	Federal Government	Ottawa, Canada	1974	Operational	Charged near market price for employee parking. SOV driving decreased by 21% (from 35% to 28%) with 17% shift to transit. Overall, 7% of workers changed travel mode.
	Municipal Government	Honolulu, HI	NA	NA	Doubled parking rates to discourage long term parking. Number of parked cars increased by 6%, and lunch hour parking availability doubled. Revenues increased 36%. No mode shifts were noted.
	Commuter Transportation Services	Los Angeles, CA	1985 to present	Operational	A $60 per month taxable allowance (except for those choosing and selected for employer parking) was provided initially in each employee's gross pay each month as part of an ETR program. AVO increased from 1.2 to 1.8 persons per vehicle.
	Hartford Steam Boiler	Hartford, CT	NA	Operational	Graduated parking charges ($110 for SOV, $75 for 2-person carpool, $40 for 3-person carpool, and $10 for 4-person carpool) implemented as part of an ETR program. A net trip reduction of 26.5% was estimated.
	California Chamber of Commerce	Sacramento, CA	NA	Operational	An 85 employee firm achieved a 23 percent reduction in SOV use through a parking cash out program.
	Sierra Research	Sacramento, CA	NA	Operational	A 31 employee firm achieved a 29 percent reduction in SOV use through a parking cash out program.
	City of West Hollywood	West Hollywood, CA	NA	Operational	A 16 percent reduction in SOV use was achieved through a parking cash out program.
	Warner Center	West Los Angeles, CA	NA	Operational	SOV use was reduced by approximately 33 percent. Carpool participation went from six to 31 percent through this parking cash out program.
	CH2M Hill	Bellevue, WA	NA	Operational	After relocating to Bellevue, WA, insufficient parking space was available for all employees. A parking charge and transportation allowance of equal amounts were available to all employees, with free parking for carpools. Trips were reduced by 28%.
	NA	Los Angeles, CA	1989	Operational	Solo driving decreased 11 percent.

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SPECIFIC MARKET-BASED STRATEGY	PROJECT SPONSOR	APPLICATION LOCATION	PROGRAM YEAR(S)	STATUS	COMMENTS
CONGESTION PRICING	Federal Transit Administration	San Francisco, CA	1994-1995	On Hold	SF Bay Bridge Toll Pricing study and experiment (Point Pricing) would charge varying rates by time of day and/or congestion levels. Program on hold due to political concerns.
	S.R. 91 Toll Road COFIROUTE/Peter Kiewit Sons (Privately Financed)	Orange Co., CA	1990-1996	Under Construction	Four ten mile express toll lanes utilizing ITS technology will be built in the median of S.R. 91 by a private consortium at a cost of $126 million. Fees will be based on time of day pricing. ADT volume of 30,000 to 40,000 projected.
	I-15 Freeway HOV Buy-in SANDAG / FTA	San Diego, CA	1993-1995	On Hold	An experimental "buy-in" option would be developed for existing HOV lanes on I-15. First a permit, then an ETC fare collection approach will be tested. Approvals from FHWA and state legislature required.
	Route A-1 Autoroute du Nord SANEF	Paris, France	1992	Operational	Route A-1 (Autoroute du Nord) implemented weekend "Green" (off-peak) and "Red" (peak) rates to moderate peak period demand. Peak of the peak demand dropped from 5,000 vph to 4,500 vph, while shoulder period use increased.
	Central Government	Singapore	1975	Operational	Vehicles with less than four occupants must purchase daily/monthly license to access downtown CBD in AM and PM peaks. Peak period traffic decreased by 23% by 1983 (40% if assume growth). Average daily air pollution decreased 10%; 30% in AM peak.
	Municipal Government	Hong Kong	1985	Discontinued	Tested electronic licenses in 1985. Technology very successful and cost effective. Peak period traffic projected to be reduced by up to 20% (though off-peak increase of 20% also projected). Program discontinued due to public opposition.
	Municipal Government	Oslo, Norway	1990	Operational	18 toll points around CBD charge a flat rate of $1.60 per day. Tolls paid manually/windshield sticker; video enforcement used. Although detailed results are not available, a 5% reduction in traffic has been estimated.
	Municipal Government	Bergen, Norway	1986	Operational	Six manual toll collection points used. Although detailed results are not available, a 6-7% reduction in traffic has been estimated.
	Municipal Government	Trondheim, Norway	1990	Operational	AVI technology charges vehicles a flat toll during daylight hours. Cost per transaction of $.20 highly cost effective.
	Municipal Government	Milan, Italy	NA	Operational	Peak period entry fees to CBD area, 50% traffic reduction noted.
	Central Government	Netherlands	1992-present	Analyzed; On Hold	Multiple cordon smart card system with time of day pricing considered to reduce congestion and pollution. Revenues to be used for new highway/transit. Tolls of between $.16 and $1.65 studied. Public opposition has placed further action on hold.
	Municipal Government	Cambridge, U.K.	1992-present	Proposed	Smart card system would charge tolls based on distance and speed when congestion occurs. Revenues would be used for public transit.
	UK Dept. of Transport	London, U.K.	1991-present	Study Underway	Study to determine pricing and social impacts of congestion pricing program underway. A previous 1975 study of London estimated a traffic reduction of 30-45% with a $3.00 per day charge.
	Central Government	Stockholm and Malmo, Sweden	1991-present	On Hold	Governmental actions implemented to support implementation of congestion pricing programs.
PAY AT THE PUMP INSURANCE		Theory Only	NA	Proposed	No Known Applications
VMT TAX	Regional Transportation Authority	Illinois	1994	Analyzed	VMT fee study for northeastern Illinois. A five cent per mile VMT fee would be roughly equivalent to a $1.25 per gallon gas tax (from CA research). A one dollar per gallon gas tax was estimated to reduce VMT in northeastern Illinois by over 22%.
	Conservation Law Foundation	Massachusetts	1993	Analyzed	See Emissions Fees.
	California Air Resources Board	California	1994	Analyzed	Study of Southern California estimated 5 to 7 percent emissions reductions using a $0.02/mile fee

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STATE-OF-PRACTICE SUMMARY

SPECIFIC MARKET-BASED STRATEGY	PROJECT SPONSOR	APPLICATION LOCATION	PROGRAM YEAR(S)	STATUS	COMMENTS
GROSS EMITTER	Sun Oil Company (Sunoco)	Philadelphia, PA	1994	Completed	155 gross emitters fully participated. $450 in repairs and $100 for completing program. Annual cost effectiveness over a 2 yr. period: $15,274/ton HC & $65,159/ton NOx.
	Arizona Department of Transportation	Phoenix, AZ	1995	Operational	Enforcement program. Six vans with remote sensing equipment perform random mobile testing. First time violators sent warnings to fix vehicles, second time violators ordered to report to inspection station or lose vehicle registration.
	Hughes Aircraft	El Segundo, CA	1992-1993	Completed	3,100 employee vehicles remote sensed at company parking facilities. 72 vehicles (most pre-1972) identified as gross emitters contributing 17% to fleet emissions. Emissions reduction costs estimated at $200-$700/ton CO; $1300-$4500/ton NOx.
	Colorado Department of Health	Colorado	1987	Completed	Accuracy of this early system found to be low.
	University of Denver	Denver, CO	1987-1989	Completed	FEAT system used, accurate to +/- 5% for CO and +/-15% for HC. HC gross emitters increased with age, however, dirtiest emitting 20% of 1983 and newer vehicles emitted more than cleanest 40% of all model years.
	Transportation Research Ctr.	Baton Rouge, LA	1992	Completed	FEAT system used. More than half CO emitted by approximately 7% of vehicles.
	California Air Resources Board	Los Angeles, CA	1991	Completed	GMR and FEAT sensors tested, high accuracy results reported.
	American Oil Company (AMOCO)	Napierville, IL	1990	Completed	Average vehicle emission system repair cost was $2,000 per vehicle based on repair of ten vehicles.
	Resources for the Future	NA	1993	Analyzed	Cost-effectiveness of multiple sensor remote sensing found to range from $4,000 to 6,000/ton HC, depending on the number of sensors (1 to 3).
	NA	Lynwood, CA	1989	Completed	Determined (using single CO only sensor) that remote sensing effective, but not a substitute for state emissions tests.
	US EPA	Hammond, IN	1992	Completed	Compared accuracy of different remote sensing systems and IM240 test. Determined that remote sensing accuracy enhanced through use of two sensing episodes, and that HC sensor unreliable.
TRANSIT PRICING	Utah Transit Authority	Utah	1979	Completed	Off-peak fares eliminated for one month. Weekday ridership increased between 4-12% (mostly diverted from auto), with 17-50% new riders. While an 8% ridership increase was reported, the hypothesis that no-long term effect occurred could not be rejected.
	UMTA (FTA)	Trenton, NJ	1979	Completed	UMTA sponsored free-fare test. Ridership gains of up to 50% in off-peak reported, but not sustained after end of experiment.
	UMTA (FTA)	Denver, CO	1979	Terminated	UMTA sponsored free-fare test. Ridership gains of up to 50% in off-peak reported, but not sustained after end of experiment. Problems with service quality and 40% loss of revenue reported.
	New York Metropolitan Transportation Authority	NYC, NY	1993-1995	On Hold	Proposed increase in free transfers and elimination of two fare zones. On hold pending budget and political outcomes.